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Ergonomics of the City: Green Infrastructure and Social Benefits

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ABSTRACT

Infrastructure systems dependably deliver diverse products and services. Green infrastructure should include ergonomics, thus delivering social AND environmental services. Ergonomics of the city can expand impact and appeal of green infrastructure.

INTRODUCTION

The majority of U.S. citizens now live in urban areas. City residents have come to expect clean air, effective waste removal, and reliable energy supplies, transportation and communication. The infrastructure that provides these goods and services is a diverse assemblage of roads, sewers, pipes, power plants and wires. Recently, trees and greenspace have come to be regarded as green infrastructure, a living system in contrast to the engineered structures of gray infrastructure.

Urban forest research has revealed a diversity of environmental, economic and social benefits. These benefits can be thought of as the goods and services that green infrastructure delivers. While studies of social benefits once trailed our understanding of environmental benefits, research in recent decades has revealed many psychosocial dynamics. It appears that the experience of nature in cities is integral to human health, well being and quality of life. This paper suggests that the ergonomics, or human dimensions, of green infrastructure is a necessary component of systems planning.

ERGONOMICS DEFINED

Simply stated, ergonomics is the process of translating human actions and needs into the physical forms of engineered or built systems. It involves designing tasks and the work or activity environment for human safety, comfort and satisfaction, as well as for optimum performance (Dul & Weerdmeester 2001). Another term is human factors. The science and practice of ergonomics emerged as people the world over began to move from agrarian work to being part of production systems, and became a recognized field during World War II, when technology and human sciences were systematically coordinated.

Ergonomics involves studies of accident analysis and prevention, understanding of human movement and cognitive functioning, as well as performance and safety

evaluations (Mital et al. 2000). This research is the basis for applied guidelines that improve human comfort and productivity. Often the research is conducted at the micro-scale, that is, as observations or measurements of the activity environment of an individual, but the resulting guidelines enhance the quality of large systems or processes.

There are a number of examples of ergonomics applications in infrastructure systems. For instance, there are many studies of the human factors of transportation. Included is analysis of the causes and prevention of accidents for improved road design, vision capacity studies of drivers in order to improve signage for driver guidance, and of course, the analysis of driver and driving controls interface within car interiors to reduce fatigue and stress. An emerging infrastructure system, the Internet, includes ergonomic research on computer use practices that reduce eyestrain and repetitive stress injuries.

INFRASTRUCTURE SYSTEMS

Infrastructure systems have been a part of cities for millennia. The Romans were known for their accomplished engineering of road and water delivery systems. Some of the basic principles of ancient systems have continued through the ages. Entirely new infrastructure systems continue to emerge, such as the electricity in the early 1900s and telecommunications in the early 2000s. The spatial intersection of infrastructure systems is complex; recent optic fiber cable installations in cities have impacted the function of roads and other systems.

Gray Systems

Referring to construction materials of concrete and steel, gray infrastructure systems contain a network of facilities and conduits that deliver a defined service or product. A system often has a large service area, encompassing more than a single city or metropolitan region. Installing or updating an infrastructure system is often a major capital investment. Construction costs include building in redundancies and backup mechanisms so that performance remains consistent, despite variation in levels of demand.

A key feature of infrastructure is that the delivery networks are hierarchically structured. Engineering specifications and construction standards differ within multiple levels of the system. System function and performance starts at the product source (such as an electrical plant or potable water intake) and differs as the system serves the region, a single city, a district or neighborhood, a street, and a household or building. Regional transportation systems, for example, typically use the road classifications of expressway, major and minor arterial roads, collector road, and local road to denote different service levels.

Ergonomics and human factors are an understated component of many infrastructure systems. Often, human factors have been retrofitted after the basic operations of a system or network have been developed and fine-tuned. For instance, greater attention to driver safety has occurred following the core installation of the U.S. transportation network.

Ergonomics design often follows citizen complaints, product improvements efforts, or efficiencies analyses. Ergonomic practices can reduce public costs associated with human stress, injury, or reduced productivity.

New Concept – Green Infrastructure

Infrastructure is valuable as it enables a wide range of economic and social activities, including community growth. Until recently it wasn't widely understood that natural and ecological systems also contribute such outcomes. With expanding scientific knowledge of green benefits in cities, many community leaders and planners understand that systems composed of key ecological and cultural features are essential to sustainable growth and productivity.

The definitions and implementations of green infrastructure are in their earliest phases (Sheladia 1998). Communities are planning networks that include regional natural community types, and significant natural features (i.e. riparian, forest, habitat, acquifer recharge), and taking steps to acquire lands. The processes of planning and implementing green infrastructure are evolving quickly as case studies and practices from states and cities are shared.

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Green infrastructure services include stormwater management, air quality (including ozone levels), and mitigating urban heat island effects. Better measures for these services are being developed. Comprehensive multi-attribute models specify both services levels and economic consequences (American Forests 1998, McPherson et al. 2002).

As the concepts and applications of green infrastructure mature it is important to integrate a human factors perspective. In order to monitor ergonomics, reliable measures of human benefits and services should be a part of the infrastructure system. A framework for the ergonomics of the city should include three sets of targets.

Benefits or Services Analysis

There are studies from many disciplines – psychology, sociology, landscape architecture, economics, geography – that document the human benefits of nature experiences in cities. A comprehensive cataloging of these services and benefits reports would be valuable, and suggest additional benefits research needs. In addition, discussion of the relative value or priority of the benefits would help define which services should be emphasized within green infrastructure systems. The service analysis may differ by land use type. For instance, expectations for service types and levels for residential areas would probably differ from retail and commercial locations.

Structure Targets

All infrastructure systems contain diverse facilities and structures types that perform different, but mutually compatible functions within the network. An important need is to identify and classify the "structures" of green infrastructure. The metro region of Minneapolis/St. Paul, MN, for instance, uses three categories for ecological infrastructure planning – natural areas, greenways and open space. A thorough definition of possible green structures in cities helps planners imagine how to best create a citywide network of natural systems units (Thompson 2002, Jackson 2003). In addition, once defined, ergonomic applications can be envisioned for the different unit types.

Performance and Delivery Targets

Once the structures and their interconnections are defined, performance standards can be developed. Existing performance standards for urban green are broad-brush, such as acres of open space per resident or canopy cover percentages. Meanwhile delivered service levels of traditional infrastructure, such as electricity transmission levels or water volumes, vary according to engineering specifications within the hierarchy of the network. They also differ on the basis of end user type. Likewise, green infrastructure performance guidelines could be drafted, and measures for achievement proposed. For example, a riparian corridor in a city would have different performance expectations than a business district pocket park. Ergonomics performance standards, based on our understanding of nature benefits, could also be applied.

CONCLUSION

Because of the density of human population in cities, complex and highly planned systems are required to efficiently and effectively deliver goods and services to every business, household and person. Infrastructure systems have fulfilled urban service delivery needs for hundreds of years.

Many engineered and built systems have emerged for specific functions and productivities. As humans are often key elements of production systems, their needs and limitations must be included in systems operations. Ergonomics and human factors are terms that describe the systematic considerations of human movement, fatigue and stress in production systems.

Green infrastructure is an emerging idea about how urban forests and green spaces can optimally generate benefits in cities using systematic planning, design and management of trees and other living materials. More science and professional practice is needed to improve understandings of how to install and manage green infrastructure most effectively in cities.

As this inevitable evolution proceeds, it is important to take into account the ergonomics of the city. With vision, green infrastructure can become an urban system that delivers human benefits and services in both the environmental and social dimensions. Attention to the ergonomics of the city provides another opportunity to expand the political appeal and fiscal support of green infrastructure.

NOTES

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